Center Innovation Fund: ARC CIF

Low Cost Mars Sample Return Utilizing Dragon Lander

Completed Technology Project (2012 - 2012)

Project Introduction

We studied a Mars sample return (MSR) mission that lands a SpaceX Dragon Capsule on Mars carrying sample collection hardware (an arm, drill, or small rover) and a spacecraft stack consisting of a Mars Ascent Vehicle (MAV) and Earth Return Vehicle (ERV) that collectively carry the sample container from Mars back to Earth orbit.

The Dragon capsule is a human rated entry vehicle built by SpaceX to deliver crew and cargo to the Space Station. For Earth orbital operations, retropropulsion thrusters (Super Draco) perform both the launch abort and the precision soft landing functions necessary to qualify it for crew transport to/from LEO. Plans are in place to flight test both capabilities. For Mars landing operations, the Super Draco thrusters were designed with deep throttling capability to accommodate the reduced gravity field. We have shown that a Dragon Capsule with minimal modification can be landed on Mars with substantial performance margin by using a lifting entry and supersonic retropropulsive landing (Lemke and Gonzales (2014) Mars Sample Return Using Commercial Capabilities: Propulsive Entry, Descent, and Landing, IEEE Aerospace Conf. Big Sky MT).   The Dragon capsule can deliver a useful payload in the 2000 kg range. This mass allocation is available to accommodate both the MAV and ERV as well as sample collection system. Thus, both the MAV and the ERV may be considered small spacecraft. We studied an MSR architecture consisting of a Dragon lander, launched by a Falcon Heavy, that carries to Mars an Ascent Vehicle and sample collection hardware, and an Earth Return Vehicle. After acquiring and packaging the samples in a return capsule, the MAV ascends from Mars to achieve trans-earth injection of the ERV and return capsule. Our study considered the trade between chemical and electric propulsion for the ERV, and showed that a chemical propulsion system was required. The ERV captures at Earth into a high orbit, with perigee selected for a long orbit lifetime and apogee selected to minimize propellant requirements. A Dragon Rider capsule, that may be automated or crewed, launches from Earth to retrieve the sample container, package it for planetary protection, and return to Earth. This plan accomplishes the sample return in one Mars mission opportunity (as opposed to three for the DS architecture). See L.G. Lemke and A. Gonzales (2014) Mars Sample Return Using Commercial Capabilities: Propulsive Entry, Descent, and Landing, IEEE Aerospace Conference, Big Sky MT.

Anticipated Benefits

N/A

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

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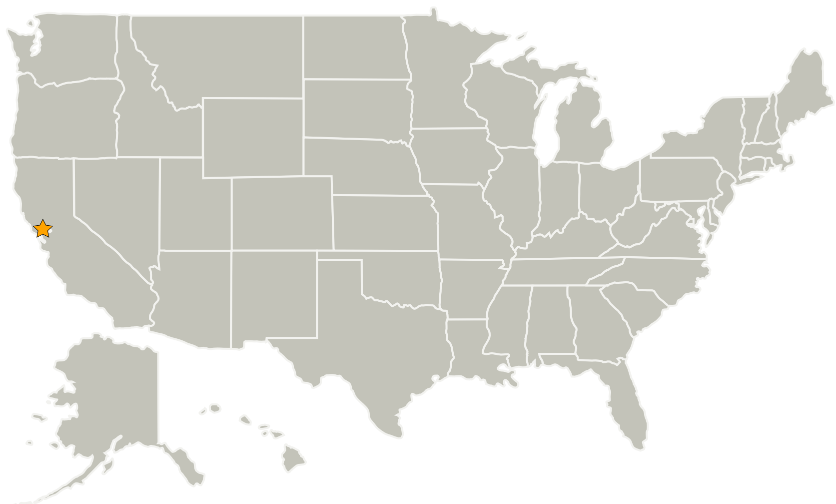
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Project Management

Program Director:
Michael R Lapointe

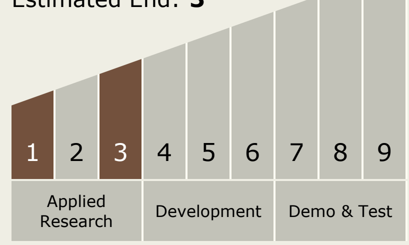
Program Manager:
Harry Partridge

Project Manager:
Carol R Stoker

Principal Investigator:
Carol R Stoker

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - └ TX15.1 Aerosciences
    - └ TX15.1.7 Computational Fluid Dynamics (CFD) Technologies